

A rock-mass behaves as a viscous body, under slight pressures, when heat and the presence of water have overcome the cohesion of its particles. But the researches of Tresca and Daubrée have shown that, when subjected to sufficiently powerful stresses, the most perfectly solid bodies we know of behave like viscous bodies, and can be made to *flow*.

In the foregoing remarks, my main object has been to show how far the physical and chemical principles, which have been established by actual experiment, are capable of explaining the phenomena observed by the geologist in studying the earth's crust. I have especially avoided invoking any causes which must be regarded as hypothetical.

Some of the actions relied upon as explaining the origin of the great features of the rock-masses which compose the earth's crust may seem at first sight small and even insignificant. But the great lesson taught by modern geological science is that such small forces, operating upon enormous masses of matter during vast periods of time, are capable of effecting the most stupendous results.

In speaking of *statical* pressure, I have not treated it as an agent of change, like heat or electricity, but simply as a condition under which these agents operate—one which may profoundly modify or control their action. Such pressure, too, may produce great effects by causing a closer contact and consequent chemical action between the molecules of a fluid made to penetrate a solid, or between the molecules of two solids forced into more perfect contact. Statical pressure may, further, prevent the escape of volatile materials even under extreme temperatures, and these substances, as in the case of the "mineralizers" of the French chemists, may exercise important influences on the solids or liquids within which they are retained.

Dynamical pressure, especially when it results in differential movements in a mass, can certainly do all that is effected by statical pressure, and perhaps something more. That such motion is converted into heat there can be no doubt; and some geologists, like the late R. Mallet and Prof. Prestwich, have argued that the heat so produced must have played an important part in the work of metamorphism. But considering the slowness with which the earth-movements have probably taken place, and the opportunities for the dissipation of this thermal energy, it may be regarded as at least doubtful if at a particular point in the rock-mass the temperature could ever have been raised to such an extent, that any very important part of the work of metamorphism ought to be ascribed to it. In the same way, we may, perhaps, regard the suggestion of Mr. Sorby that, during great earth-movements, mechanical energy is directly converted into chemical energy, as one in favour of which no convincing evidence has as yet been adduced.

It is at least conceivable that the realm of excessively *high* pressures is one in which phenomena may be displayed which are as anomalous as those exhibited under extremely *low* pressures—the high *vacua* of Mr. Crookes. But until such effects have been demonstrated by actual experiment, it is unwise to invoke their aid in geological hypothesis. My great object, in the remarks I have ventured to offer you this evening, has been to show that, on well-established physical and chemical principles, the phenomena, which are exhibited by rock-masses that have been subjected to great pressures, are capable of satisfactory explanation.

THE UNIFORM PENNY POST.

OF all the jubilees that are now being celebrated, there is none which has had a more beneficial influence on the age than that celebrated last week at

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the Guildhall, with such success and good management. There are some who deplore the decay of letter-writing, and even a few who regard the penny post as an unmitigated evil, but no one can fail to perceive that the conduct of the great commercial business of this country would have been impossible without cheap postage.

We are not celebrating the penny post. This was proposed in 1659, by one John Hill, an attorney of York—curiously enough a namesake of Sir Rowland's—who showed its practicability and advocated free trade in letter-carrying. He proposed a rate of 1*d.* in England, 2*d.* in Scotland, and 4*d.* in Ireland, as well as 3*d.* per ounce for small parcels.

Nor are we celebrating the invention of adhesive stamps, but the introduction, in 1840, of that great measure which swept away a sliding scale of postage of single letters written on single sheets of paper which varied between 4*d.* and 1*s.*, and a system of franking that had grown, even in the reign of our present Queen, to a most shameful abuse. Envelopes or covers and enclosures involved double postage. If the letter weighed an ounce the rate was quadrupled. A single letter, London to Brighton, cost 8*d.*, to Edinburgh 1*s.* 1½*d.*, to Cork 1*s.* 5*d.*; or if it weighed 1½ ounces, to Edinburgh 7*s.* 7½*d.*, to Cork 9*s.* 11*d.* The number of letters passing through the post in 1839 was 76,000,000. In 1889, it amounted to 1,600,000,000, and this excludes newspapers, post-cards, books, and parcels. The grand total for 1889 was 2,362,000,000.

It is not too much to say that the transport of this enormous mass of material would have been impossible but for the advent of steam. Railways and steam-boats have led to the possibility of the uniform post. Telegraphs have made its administration practical and simple. Without these practical applications of science its success would have been impossible. Pack-horses, mail-coaches, and sailing-vessels, would have failed to transport mails with the celerity, trustworthiness, and regularity, that are the essentials of a true postal service.

The Stuarts made the Post Office a monopoly of the Crown; and the Commons, who in Charles's day denounced the establishment of the monopoly, promptly proceeded by Cromwell's soldiers to put down John Hill and his free trade in letters. It has remained the monopoly of the State, and its work is well done, but this is due to the fact that it is so well supervised by the public itself, every member of which is interested in its well-working. If the breakfast table is not garnished with the expected letters, if any abuse, want of accommodation, or delay occurs, the press or the House of Commons soon wants to know the reason why, and the remedy is at once applied. In fact, the public is the master and the postal service knows it. In no service in the world can there be found more zeal, energy, and attention. The rewards are not quite so evident. Although this is the jubilee year, Post Office names were conspicuous by their absence from the Queen's Birthday honours, and even such ardent reformers as Mr. Henniker Heaton, with an ignorance that is surprising, speak in contemptuous terms of the unimpeachable mind of the red-taped official.

The most scientific branch of the Post Office is unquestionably the telegraphic. Many fears were entertained that its efficiency would deteriorate under the supposed chilling influence of Government monopoly, but these fears have not been realized. Facilities have been increased, business has been developed, improvements have been introduced, new processes have not only been adopted but originated, and our Postal Telegraph Department unquestionably holds the most prominent position in the world at the present moment. The number of messages, which in 1869, the year before the transfer, amounted to 6,000,000, now reaches over 60,000,000. Duplex, quadruplex, and sexuplex methods have been made practical. The automatic system of Wheatstone,

which its ardent inventor hoped would work well at 120 words, now works equally well at 600 words a minute.

The telephone, owing to mismanagement and the operation of our Patent Laws, has not received much development in England yet; but with the expiry of the patents at the end of this year it is hoped that every post-office will become an exchange, and the business of telephony will flourish as well in England as it has in Sweden and Norway and some of the smaller States in Europe. Competition and free trade will certainly tend to bring this marvellous and beautiful apparatus within the sphere of every domestic circle.

It is marvellous how science is rapidly becoming a household god. The electric light, bells, and telephones must prompt all to some knowledge of electricity. Ventilation, sanitation, pure water, warming apparatus, lead to a knowledge of other scientific principles. The laws of Nature are rapidly but surely becoming as familiar in our mouths as household words.

PENDULUM ELECTROMETER.

IN order to obtain an inexpensive apparatus by which the nature of electrostatic measurements could be clearly presented to students, and the measurements carried out before a class with ease and despatch in abso-

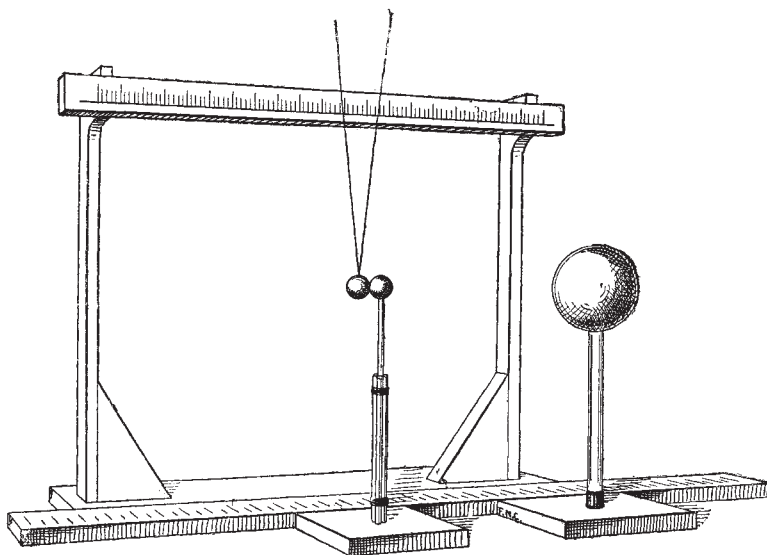
lute units, Prof. Mayer, of the Stevens Institute of Technology, of New Jersey, has arranged the apparatus shown in the accompanying figure.

It consists of a gilt pith ball of 1 cm. radius, made of pieces of pith cemented together, and suspended at a distance of 364 cm. from the ceiling by a very fine silk fibre passed through a small staple driven into the ball. The ends of the fibres are attached to the ceiling at a distance of 52 cm. apart, and arranged so that the suspended ball can be raised or lowered, until it is at the same height as a brass ball, also of 1 cm. radius, supported on a glass rod, coated while hot with paraffin wax. A force of 1 dyne acting on the suspended ball deflects it through 13.3 mm., and, as 2° deflection was the maximum employed, the scale was inclined to the horizontal so as to coincide with the chord of an angle of 2°.

If a charge be given to the two small balls when in contact, and when therefore it will divide equally between them, the charge on either in *absolute electrostatic units* equals

$$D \sqrt{\frac{d}{1.33}},$$

where d is the deflection in centimetres of the pendulum from the vertical, and D the distance in centimetres between the centres of the two balls.



To test the sensitiveness of the apparatus, the ball on the stand was placed at various distances from the suspended one, and the force between them observed. The law of the inverse squares was found to be verified with an error of less than 1 per cent. when D was over 5.4 cm. Next the gradual diminution of the deflection when the brass ball on the stand was in a fixed position was used to measure the rate of loss of charge, and it was found that the measured leakage to earth was proportional to the measured charges with a considerable degree of accuracy in several experiments, and with a maximum error of 20 per cent. in the most discordant experiments. Then the pendulum electrometer was used to measure the electric distribution over the surface of a cylinder, a proof plane being employed to convey the charge from different parts of the surface of the cylinder to the pendulum electrometer, and results were obtained closely agreeing with those obtained by Coulomb. Lastly, the potential of the large sphere was experimentally determined in absolute electrostatic units for different charges given to it.

NOTES.

WE are glad to learn that the President of the French Republic has conferred on Prof. Sylvester and Prof. Cayley the "Décoration d'Officier de la Légion d'Honneur." This honour has been granted in consequence of a request addressed to the French Minister of Foreign Affairs by the President and other members of the Academy of Sciences.

LORD RAYLEIGH has been elected a corresponding member of the Imperial Academy of Sciences in Vienna.

THE French Association for the Advancement of Science will hold its nineteenth meeting at Limoges from August 7 to 14. Various English men of science have been invited by the Bureau of the Association to attend the meeting, and they are asked to let their decision be known before July 1. Those of them who accept the invitation will be the guests of the Municipality of Limoges.

THE Queen has been pleased to approve of the grant of Civil List pensions to Miss Charlotte, Ruth, Margaret, and Rose,